

**GEOTECHNICAL INVESTIGATION REPORT  
PROPOSED DRUMHELLER SLOUGH  
OUTFALL STRUCTURE  
COLUSA COUNTY, CALIFORNIA**

**FEBRUARY 23, 2001**

**This document was prepared for use only by the client, only for the purposes stated, and within a reasonable time from issuance. Non-commercial, educational, and scientific use of this report by regulatory agencies is regarded as a “fair use” and not a violation of copyright. Regulatory agencies may make additional copies of this document for internal use. Copies may also be made available to the public as required by law. The reprint must acknowledge the copyright and indicate that permission to reprint has been received.**

Date: February 23, 2001  
File: 23-484421

Mr. Steve Sullivan  
Ensign & Buckley Consulting Engineers  
3327 Longview Drive  
North Highlands, California 95660

**Subject: Geotechnical Investigation Report  
Proposed Drumheller Slough Outfall Structure  
Colusa County, California**

Dear Mr. Sullivan:

Kleinfelder is pleased to present the attached geotechnical investigation report for the proposed Drumheller Slough Outfall Structure to be located at the mouth of Drumheller Slough in Colusa County, California. The purpose of our investigation was to explore and evaluate the subsurface conditions at various locations on the site in order to develop geotechnical engineering recommendations for project design and construction.

Based on the results of our field investigation, laboratory testing, and engineering analyses, it is our professional opinion the site may be developed for the proposed outfall structure using conventional grading and foundation construction techniques. Recommendations regarding the geotechnical aspects of project design and construction are presented in the herein.

We appreciate the opportunity of providing our services for this project. If you have questions regarding this report or if we may be of further assistance, please contact the undersigned.

Sincerely,

**KLEINFELDER, INC.**

Bradford L. Quon  
Staff Engineer

Raymond Costa, Jr., PE  
Project Manager

BLQ:RC:eas

cc: Client (4)

## TABLE OF CONTENTS

CHAPTER	PAGE
<b>1</b>	<b>INTRODUCTION..... 1</b>
1.1.	GENERAL ..... 1
1.2.	PROPOSED CONSTRUCTION..... 1
1.3.	PURPOSE AND SCOPE OF SERVICES..... 2
<b>2</b>	<b>SITE CONDITIONS ..... 3</b>
2.1.	SURFACE ..... 3
2.2.	SUBSURFACE..... 3
<b>3</b>	<b>CONCLUSIONS AND RECOMMENDATIONS ..... 4</b>
3.1.	GENERAL ..... 4
3.2.	SITE PREPARATION ..... 4
3.2.1.	Stripping and Grubbing ..... 4
3.3.	TEMPORARY EXCAVATIONS..... 4
3.3.1.	General..... 4
3.3.2.	Excavations and Slopes ..... 4
3.3.3.	Construction Considerations..... 5
3.4.	ENGINEERED FILL ..... 5
3.4.1.	Materials ..... 5
3.4.2.	Compaction Criteria ..... 6
3.5.	PERMANENT SLOPES AND EROSION PROTECT ..... 6
3.5.1.	General..... 6
3.5.2.	Erosion Control..... 6
3.6.	SPREAD FOUNDATIONS ..... 6
3.6.1.	Allowable Bearing Pressures ..... 6
3.6.2.	Estimated Settlements ..... 7
3.6.3.	Lateral Resistance ..... 7
3.7.	RETAINING/STOPLOG WALLS ..... 8
3.7.1.	Lateral Earth Pressures ..... 8
<b>4</b>	<b>ADDITIONAL SERVICES..... 9</b>
4.1.	PLANS AND SPECIFICATIONS REVIEW..... 9
4.2.	CONSTRUCTION OBSERVATION AND TESTING ..... 9
<b>5</b>	<b>LIMITATIONS ..... 10</b>
<b>PLATES</b>	
1	Site Location Map
2	Boring Location Map

## **APPENDIX**

- A     Field Exploration and Laboratory Testing
- B     Important Information About Your Geotechnical Report

**GEOTECHNICAL INVESTIGATION REPORT**  
**PROPOSED DRUMHELLER SLOUGH OUTFALL STRUCTURE**  
**DRUMHELLER SLOUGH**  
**COLUSA COUNTY, CALIFORNIA**

**1 INTRODUCTION**

---

**1.1. GENERAL**

In this report we present the results of our geotechnical investigation for a Proposed Drumheller Slough Outfall Structure to be located at Drumheller Slough in Colusa County, California. The purpose of our investigation was to explore and evaluate the subsurface conditions at various locations on the site in order to develop geotechnical engineering recommendations for project design and construction. The site location relative to topographic features is shown on Plate 1.

This report includes our recommendations related to the geotechnical aspects of project design and construction. Conclusions and recommendations presented in this report are based on the subsurface conditions encountered at the locations of our explorations and the provisions and requirements outlined in the ADDITIONAL SERVICES and LIMITATIONS sections of this report. Recommendations presented herein should not be extrapolated to other areas or used for other projects without our prior review.

**1.2. PROPOSED CONSTRUCTION**

The proposed project will involve the construction of a water control structure at the mouth of Drumheller Slough near Butte Creek. The water control facility will consist of a stop log support with a new concrete structure.

Grading plans were not available at the time this report was prepared; however, as site topography is relatively level, earthwork cuts and fills of about 7 to 8 feet in vertical extent are expected to achieve a level footing pad.

A plot plan indicating the proposed project layout is shown on Plate 2.

### **1.3. PURPOSE AND SCOPE OF SERVICES**

The scope of our services was outlined in our proposal dated February 8, 2000, and included the following:

- Exploration of the subsurface conditions at various locations within the area of the proposed construction utilizing 1 drilled boring.
- Limited laboratory testing of representative samples obtained during the field investigation to evaluate relevant engineering parameters of the subsurface soils.
- Engineering analyses on which to base our recommendations for the design and construction of the geotechnical aspects of the project.
- Preparation of this report which includes:
  - A description of the proposed project
  - A description of the surface and subsurface site conditions encountered during our field investigation
  - Recommendations related to the geotechnical aspects of:
    - Site preparation and engineered fill
    - Permanent slopes and erosion protection
    - Foundation design and construction
    - Earth retaining walls
- An appendix which includes a summary of our field investigation and laboratory testing programs.

## **2 SITE CONDITIONS**

---

### **2.1. SURFACE**

The site consists of an approximate 10 foot wide Drumheller Slough flowing south into Butte Creek. The site is bounded by Putnam Road to the west and Butte Creek to the east and south. A building was observed northwest of the site along Putnam Road. A major growth of trees and vegetation was observed to line the banks and shores of Drumheller Slough on the east and west. The existing structures at this site consist of two sandbag walls connected to an 84 inch diameter corrugated metal pipe serving as the existing outfall structure.

Site topography is relatively level. Based on the Drumheller Slough General Plan and Details drawing prepared by Ensign & Buckley Consulting Engineers, the existing banks of Drumheller Slough are sloped at an approximate 2(h) to 1(v) configuration.

### **2.2. SUBSURFACE**

Near-surface soils encountered in our boring consisted predominantly of hard dark brown, silty clay to a depth of about 5 feet below existing site grade. Below these near-surface silty clay soils, very stiff, olive brown clay was encountered to a depth of about 14 feet below existing site grade. The clay was classified as high plasticity based on an Atterberg Limits index test (Liquid Limit, LL - 60, Plasticity Index, PI - 41). An approximate 5½ foot thick layer of medium stiff fine sandy silt was encountered beneath the clay. Medium dense fine sand with a trace of silt was encountered at about 18½ feet to the termination depth of the boring at about 21½ feet below existing site grade.

At the time of our field investigation, free groundwater was encountered in Boring B-1 at a depths of 6½ feet, below existing site grade. It should be noted that groundwater and soil moisture conditions within the area will vary depending on rainfall, irrigation practices, and/or runoff conditions not apparent at the time of our field investigation.

A discussion of the field investigation and laboratory testing programs is presented in Appendix A of this report. Detailed descriptions of the subsurface conditions encountered during our field investigation are presented on the Logs of Borings, Plates A-3 of the appendix.

### **3 CONCLUSIONS AND RECOMMENDATIONS**

---

#### **3.1. GENERAL**

Based on the results of our field investigation, laboratory testing, and engineering analyses, it is our professional opinion the site may be developed for the proposed outfall structure using conventional grading and foundation construction techniques. Recommendations regarding the geotechnical aspects of project design and construction are presented in the herein.

#### **3.2. SITE PREPARATION**

##### **3.2.1. Stripping and Grubbing**

Prior to general site grading, existing vegetation, organic soil, and any debris should be stripped and disposed of outside the construction limits. We estimate the depth of removal to be a few inches over a majority of the site. Deeper stripping or grubbing may be required where concentrations of organic soils or tree roots are encountered during site grading.

#### **3.3. TEMPORARY EXCAVATIONS**

##### **3.3.1. General**

All excavations must comply with applicable local, state, and federal safety regulations including the current OSHA Excavation and Trench Safety Standards. Construction site safety generally is the sole responsibility of the Contractor, who shall also be solely responsible for the means, methods, and sequencing of construction operations. We are providing the information below solely as a service to our client. Under no circumstances should the information provided be interpreted to mean that Kleinfelder is assuming responsibility for construction site safety or the Contractor's activities; such responsibility is not being implied and should not be inferred.

##### **3.3.2. Excavations and Slopes**

The Contractor should be aware that slope height, slope inclination, or excavation depths (including utility trench excavations) should in no case exceed those specified in local, state,



and/or federal safety regulations (e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations). Such regulations are strictly enforced and, if they are not followed, the Owner, Contractor, and/or earthwork and utility subcontractors could be liable for substantial penalties.

Flatter slopes and/or trench shields may be required if loose, cohesionless soils and/or water are encountered along the slope face.

### 3.3.3. Construction Considerations

Heavy construction equipment, building materials, excavated soil, and vehicular traffic should not be allowed within 1/3 the slope height from the top of any excavation. Where the stability of adjoining buildings, walls, or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning may be required to provide structural stability and to protect personnel working within the excavation. Shoring, bracing, or underpinning required for the project (if any) should be designed by a professional engineer registered in the State of California.

During wet weather, earthen berms or other methods should be used to prevent runoff water from entering all excavations. All runoff water and/or groundwater encountered within the excavation(s) should be collected and disposed of outside the construction limits.

## 3.4. ENGINEERED FILL

### 3.4.1. Materials

All engineered fill soils should be nearly-free of organic or other deleterious debris, of low plasticity, and less than 3 inches in maximum dimension. In general, well-graded mixtures of gravel, sand, non-plastic silt, and small quantities of cobbles, rock fragments, and/or clay are acceptable for use as engineered fill. Specific requirements for engineered fill, as well as applicable test procedures to verify material suitability, are provided below.

In general, near-surface, on-site clay soils similar to those encountered in our exploratory boring may be used for engineered fill provided they are adequately moisture-conditioned during placement (see section below entitled "Compaction Criteria"). All imported fill materials to be used for engineered fill should be sampled and tested by the project Geotechnical Engineer prior to being transported to the site.

#### 3.4.2. Compaction Criteria

Expansive soils used for engineered fill should be uniformly moisture-conditioned to between 2 and 5 percent above the optimum moisture content, placed in horizontal lifts less than 8 inches in loose thickness, and compacted to between 88 and 92 percent relative compaction. Disking and/or blending may be required to uniformly moisture-condition soils used for engineered fill.

### **3.5. PERMANENT SLOPES AND EROSION PROTECT**

#### 3.5.1. General

We recommend all cut and fill slopes up to a maximum height of 10 feet be constructed at a gradient no steeper than 2(h):1(v).

#### 3.5.2. Erosion Control

To reduce the potential for surface erosion, all cut and fill slopes should be revetted as appropriate

### **3.6. SPREAD FOUNDATIONS**

#### 3.6.1. Allowable Bearing Pressures

We recommend spread footings constructed of reinforced concrete and founded on undisturbed native soil be used for support of the proposed outfall structure. For this structure, footings should be a minimum of 12 inches wide and embedded a minimum of 18 inches below the

lowest final adjacent subgrade<sup>1</sup>. An allowable bearing pressure of 1,500 pounds per square foot (psf) may be used for spread foundations with the above minimum dimensions.

The allowable bearing pressure will vary with footing width and embedment. Therefore, the minimum allowable bearing pressure provided above may be increased by 250 psf for each additional foot of width and by 500 psf for each additional foot of embedment up to a maximum allowable bearing pressure of 4,000 psf.

The allowable bearing pressure provided above is a net value; therefore, the weight of the foundation (which extends below grade) may be neglected when computing dead loads. The allowable bearing pressure applies to dead plus live loads, includes a calculated factor of safety of at least 3, and may be increased by 1/3 for short-term loading due to wind or seismic forces.

### 3.6.2. Estimated Settlements

Total settlement of an individual foundation will vary depending on the plan dimensions of the foundation and the actual load supported. Based on anticipated foundation dimensions and loads, we estimate maximum settlement of foundations designed and constructed in accordance with the preceding recommendations to be on the order of  $\frac{3}{4}$  inch. Differential settlement between similarly loaded, adjacent footings is expected to be less than  $\frac{1}{2}$  inch provided footings are founded on similar materials (e.g., all on native soil). Differential settlement between adjacent footings founded on dissimilar materials (e.g., one footing on soil and one footing on rock) may approach the maximum, anticipated total settlement (i.e.,  $\frac{3}{4}$  of an inch). Additional reinforcement of continuous footings traversing cut/fill transitions, deepened footings founded on similar materials, or overexcavation and replacement of the cut portion of the building pad may be required to reduce differential settlement or structural distress resulting from non-uniform foundation support conditions. Settlement of all foundations is expected to occur rapidly and should be essentially complete shortly after initial application of the loads.

### 3.6.3. Lateral Resistance

Resistance to lateral loads (including those due to wind or seismic forces) may be provided by frictional resistance between the bottom of concrete foundations and the underlying soils, and by

---

<sup>1</sup>*Within this report, subgrade refers to the top surface of undisturbed native soil, native soil compacted during site preparation, or engineered fill.*

passive soil pressure against the sides of the foundations. A coefficient of friction of 0.30 may be used between cast-in-place concrete foundations and the underlying soil. Passive pressure available in engineered fill or undisturbed native soil may be taken as equivalent to the pressure exerted by a fluid weighing 260 pounds per cubic foot (pcf) in a drained condition or 160 pcf in a submerged condition.

Lateral resistance parameters provided above are ultimate values. Therefore, a suitable factor of safety should be applied to these values for design purposes. The appropriate factor of safety will depend on the design condition and should be determined by the project Structural Engineer. Depending on the application, typical factors of safety could range from 1.0 to 1.5.

### 3.7. RETAINING/STOPLOG WALLS

#### 3.7.1. Lateral Earth Pressures

If retaining or stoplog walls are utilized in this project, they should be designed to resist the earth pressure exerted by the retained, compacted backfill plus any additional lateral force that will be applied to the wall due to surface loads placed at or near the wall. The design criteria for retaining or stoplog walls are presented below.

**Table 2. Design Criteria for Retaining or Stoplog Walls (allowable values)**

Backfill Configuration	Earth Pressure	Equivalent Fluid Density (pcf)	
		Drained	Submerged
Level	Active	45	80
	At Rest	60	90
Sloping (2h:1v)	Active	85	85
	At Rest	95	95
Sloping (3h:1v)	Active	60	95
	At Rest	85	100
Level	Passive	260	170

Surcharge factor = 0.4 x surcharge pressure

Earthquake = constant pressure of 9H (all backfill configurations)

Friction factor = 0.30 (friction and passive may be combined w/o reduction)

Settlement/subsidence = ½ inch all structures with less than 9 ft. backfill

## **4 ADDITIONAL SERVICES**

---

### **4.1. PLANS AND SPECIFICATIONS REVIEW**

We recommend Kleinfelder conduct a general review of final plans and specifications to evaluate that our earthwork and foundation recommendations have been properly interpreted and implemented during design. In the event Kleinfelder is not retained to perform this recommended review, we will assume no responsibility for misinterpretation of our recommendations.

### **4.2. CONSTRUCTION OBSERVATION AND TESTING**

We recommend that all earthwork during construction be monitored by a representative from Kleinfelder, including site preparation, placement of all engineered fill and trench backfill, construction of slab and all foundation excavations. The purpose of these services would be to provide Kleinfelder the opportunity to observe the soil conditions encountered during construction, evaluate the applicability of the recommendations presented in this report to the soil conditions encountered, and recommend appropriate changes in design or construction procedures if conditions differ from those described herein.

## 5 LIMITATIONS

---

Recommendations contained in this report are based on our field observations and subsurface exploration, limited laboratory tests, and our present knowledge of the proposed construction. It is possible that soil conditions could vary between or beyond the points explored. If soil conditions are encountered during construction which differ from those described herein, we should be notified immediately in order that a review may be made and any supplemental recommendations provided. If the scope of the proposed construction, including the proposed loads or structural locations, changes from that described in this report, our recommendations should also be reviewed.

We have prepared this report in substantial accordance with the generally accepted geotechnical engineering practice as it exists in the site area at the time of our study. No warranty is expressed or implied. The recommendations provided in this report are based on the assumption that an adequate program of tests and observations will be conducted by Kleinfelder during the construction phase in order to evaluate compliance with our recommendations.

This report may be used only by the client and only for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both on site and off site) or other factors may change over time, and additional work may be required with the passage of time. Any party other than the client who wishes to use this report shall notify Kleinfelder of such intended use. Based on the intended use of the report, Kleinfelder may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else will release Kleinfelder from any liability resulting from the use of this report by any unauthorized party.

## **APPENDIX A FIELD INVESTIGATION AND LABORATORY TESTING**

---

### **FIELD INVESTIGATION**

#### **General**

The subsurface conditions at the site were explored on July 28, 2000 by drilling one boring to a depth of about 21 ½ feet below existing grade. The boring was drilled using a CME-55 truck-mounted drill rig equipped with 6 inch-diameter hollow stem auger. The locations of borings performed for this investigation are shown on Plate 2 of the report.

The borings was located in the field by visual sighting and/or pacing from existing site features. Therefore, the location of borings shown on Plate 2 should be considered highly approximate and may vary from that indicated on the plate.

Our engineer maintained a log of the borings, visually classified soils encountered according to the Unified Soil Classification System (see Plate A-1), and obtained relatively undisturbed and bulk samples of the subsurface materials. A key to the Logs of Borings is presented on Plate A-2 of this appendix; the boring log is presented on Plates A-3

#### **Sampling Procedures**

Soil samples were obtained from the borings using either a Modified California or Standard Penetration Sampler driven 18 inches (unless otherwise noted) into undisturbed soil using a 30-inch drop of a 140-pound hammer. Blow counts were recorded at 6-inch intervals for each sample attempt and are reported on the logs in terms of blows-per-foot for the last foot of penetration. Soil samples obtained from the borings were packaged and sealed in the field to reduce moisture loss and disturbance, and returned to our Sacramento laboratory for further testing. After borings were completed, they were backfilled with the drill cuttings.

## **LABORATORY TESTING**

### **General**

Laboratory tests were performed on selected samples to aid in soil classification and to evaluate physical properties of the soils which may affect the geotechnical aspects of project design and construction. A description of the laboratory testing program is presented below; a summary of all laboratory tests performed is presented on the Summary of Laboratory Tests, Plate A-4

### **Sieve Analysis**

Sieve analyses were performed to evaluate the gradational characteristics of the material and to aid in soil classification. Tests were performed in general accordance with ASTM Test Method C 136. Results of these tests are presented on the logs and are summarized on the Summary of Laboratory Tests, Plate A-4, and Sieve Curve, Plate A-5.

### **Atterberg Limits**

Atterberg Limits tests were performed to aid in soil classification and to evaluate the plasticity characteristics of the material. Additionally, test results were correlated to published data to evaluate the shrink/swell potential of near-surface site soils. Tests were performed in general accordance with ASTM Test Method D 4318. Results of these tests are presented on the logs and are summarized on the Summary of Laboratory Tests, Plate A-4, and the Plasticity Chart, Plate A-6.

### **Unconfined Compression**

An unconfined compression test was performed on a selected, undisturbed sample to evaluate the undrained shear strength of the fine-grained site soils. Test procedures were in general accordance with ASTM Test Method D 2166. Results of this test are presented on the Summary of Laboratory Tests.



## **LIST OF ATTACHMENTS**

The following plates are attached and complete this appendix.

Plate A-1	Unified Soil Classification System
Plate A-2	Log Key
Plate A-3	Log of Boring B-1
Plate A-4	Summary of Laboratory Tests
Plate A-5	Sieve Curve
Plate A-6	Plasticity Chart

**APPENDIX B**  
**IMPORTANT INFORMATION ABOUT**  
**YOUR**  
**GEOTECHNICAL INVESTIGATION REPORT**

---